4A6(1) – Structural Design (‘Structures 1’) [5 credits]

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Module organisation
Department of Civil, Structural and Environmental Engineering.

This module runs for 9 weeks of First Semester, with three lectures and a two-hour design study every week.

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<th>Semester</th>
<th>Start Week</th>
<th>Hours of Associated Practical Sessions</th>
<th>End Week</th>
<th>Lectures Per Week</th>
<th>Total</th>
<th>Tutorials Per Week</th>
<th>Total</th>
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<td>10</td>
<td>3</td>
<td>27</td>
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<td>18</td>
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Total Contact Hours: 45

Module description, aims and contribution to programme
In this module, SS students learn to design assemblages of structural elements. Much of the subject matter addresses the design of multistorey buildings, with an emphasis on the interactions of different structural elements – beams, columns, and connections - and on means of providing global stability of buildings. The analysis of statically indeterminate assemblages using the moment distribution method is covered, along with the use of moment redistribution in the design of RC structures. Standard methods of designing more complex structural elements are also covered: RC slabs, laterally unrestrained steel beams and the simple design method for steel columns. The module takes place in Semester one, and supports the later optional course in Advanced Structural Design. It builds upon SF courses in Structures and Mechanics of Solids, an JS courses on Structural Design and Structural Analysis. The module consists of lectures and design studies.

Learning outcomes
At the end of the module students should be able to
1. describe the methods used to provide global stability in multi-storey buildings;
2. select an appropriate method of ensuring lateral stability for given steel and RC building frames;
3. choose an appropriate floor beam and column layout for a multi-storey building;
4. analyse statically indeterminate structures using the moment distribution method;
5. apply moment redistribution to the design of RC structures;
6. design RC slabs using design code methods;
7. calculate the lateral torsional buckling capacity of steel beams using design code methods;
8. calculate the resistance of steel and RC members under biaxial bending and axial load;
9. describe the types of failure displayed by bolted and welded steel connections and evaluate the resistance of same;
10. distinguish between simple, semi-rigid and rigid beam-to-column connections and associate these with global frame behaviour;
11. assess the influence of boundary conditions on the effective lengths of columns in multi-storey buildings;
12. design structural steel columns and slender RC columns in multi-storey buildings;

Module content
- Stability of structures
- Structural analysis using the moment distribution method
- Moment redistribution
- Design of RC slabs
- Design of slender RC columns
- Multistorey steel buildings: floor layouts and frame stability
- Connections in structural steelwork
- Lateral-torsional buckling of steel beams
- Combined biaxial bending and axial forces (elastic and plastic behaviour)
- Design of steel columns in multi-storey frames

Teaching strategies
Learning material is presented in lectures and applied in weekly design study sessions. Lectures present the context of the module, with an emphasis on current construction methods and structural engineering practice. The relevant theory of structural mechanics is developed towards the design expressions and procedures set out in structural design codes. Sample problems are covered in lectures, but a major focus is in providing students with the information and guidance they require to apply the lecture material to the solution of the problems they encounter in weekly design study sessions. In these design studies, students are encouraged to collaborate and exchange ideas and information. In some weeks, designs are required to be submitted at the end of the timetabled session, in other weeks, students are required to complete the work afterwards.

Assessment
80% of the assessment is due to a two-hour examination held at the end of the year. The remaining 20% is allocated for submitted design studies.

Required textbook

- Reinforced and Prestressed Concrete Design, O’Brien and Dixon, *Longman*
- Reinforced and Prestressed Concrete, Kong and Evans, *Van Nostrand Reinhold*
- Reinforced Concrete Structures, Park and Paulay, *Wiley*
- Structural Steelwork Design, Dowling, Owens and Knowles, *Butterworths*
- Structural Steelwork Design to BS5950, Morris and Plum, *Longman*
- Design of Structural Steelwork, McKenzie, *Macmillan*